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ABSTRACT

Rwanda, a small country in Africa, has experienced declines in per capita food production. Fish culture is one part of a many-stranded effort to increase food production and food security by intensifying the use of land resources to produce a much-needed protein crop. Beginning in 1983, the Rwanda National Fish Culture Project has assisted farmers with the upgrading of their fish ponds and identified and provided a species suitable for the high elevation, cool water environment. Average annual production among participants has been raised from 300 kilograms to 1,550 kilograms per hectare. New technologies like fish culture must conform with the environment and activities of the farming system. Thus, rural extension is relevant in providing technological assistance to farmers. Data were obtained from 186 Rwandan farmers throughout the nation who had active ponds for 2 years and who received extension services during that period. Responses to the survey suggest a relatively uniform expectation for continuing fish culture, even though many factors affecting the sustainability of aquaculture as a farm enterprise are related to infrastructure beyond farmer control. A great deal of spontaneous emulation is occurring outside the project. Neighbors and relatives are constructing fish ponds, often without technical assistance. One threat to the evolution of fish culture is improperly constructed ponds. These ponds are too small, leaky, or have improper water temperatures, shortcomings that will undermine the success achieved by project participants. The paper discusses the necessary corrective or technical assistance to these emulators to avoid unnecessary failures. (ALL)

THE SUSTAINABILITY OF AQUACULTURE AS A FARM ENTERPRISE: IMPACTS AND CONSEQUENCES OF FISH CULTURE IN RWANDA*

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abstract

Rwanda has experienced recent declines in per capita food production. Fish culture is one part of a many-stranded effort to increase food production and food security by intensifying the use of land resources to produce a much-needed protein crop. Beginning in 1983, the Rwanda National Fish Culture Project has assisted farmers with the upgrading of their ponds and identified and provided a species suitable for the high-elevation, cool water environment. This paper endeavors to develop and apply a model explaining the relative fit and continuity of fish culture in the Rwandan farming system. New technologies like fish culture must conform with the environments where they will be used and interact positively with other activities within the farming system. Important questions pertain to the amount and quality of technical assistance farmers are receiving, the degree to which farmers have adopted the technical package extended to them, and existence of various signs and conditions that signal the incorporation of fish culture into the cycle and mosaic of farm activity.

Data were obtained from a sample of 186 Rwandan farmers taken from project rolls throughout the nation. The data are representative of project participants who had active ponds in the previous two years and who received extension services during that period.

The survey responses suggest a relatively uniform expectation for continuing fish culture, even though many of the factors affecting the sustainability of aquaculture as a farm enterprise relate to the provision of infrastructure that is beyond farmer control. The conclusions examine the implications of the study for other farm activities, the role of women, and the organization and delivery of extension services.

THE SUSTAINABILITY OF AQUACULTURE AS A FARM ENTERPRISE: IMPACTS AND CONSEQUENCES OF FISH CULTURE IN RWANDA*

Introduction

Rwanda is one of the smallest countries on the African continent. It also is one of the most densely populated. Like many other subsaharan nations it has experienced recent declines in per capita food production. A high birth rate, mountainous terrain, and small farm sizes make the threat of famine and seasonal food shortage an immediate concern (Cambrezy, 1981; SESA, 1987). Fish culture is one part of a many-stranded effort to increase food production and food security by intensifying the use of land resources to produce a much-needed protein crop (Schmidt and Vincke, 1981).

Although first introduced by Belgian colonialists in the 1950's, fish culture has experienced a renaissance in Rwanda (Hishamunda and Moehl, 1989). Beginning in 1983, the Rwanda National Fish Culture Project has assisted farmers with the upgrading of their ponds and identified and provided a species suitable for the high-elevation, cool water environment. Average annual production among project participants has been raised from an initial yield of 300 kilograms to 1,550 kilograms per hectare (Hishamunda, 1989).

This paper endeavors to develop and apply a model explaining the relative fit and continuity of fish culture in the Rwandan farming system. Many agricultural development efforts fail to adequately lodge new activities in the array and rhythm of existing endeavors (Molnar et al., 1987; Pollnac et al., 1982 . New technologies like fish culture must conform with the environments where they will be used and interact positively with other activities within the farming system (Francis and Hildebrand, 1990:8)

Important questions pertain to the amount and quality of technical assistance farmers are receiving, the degree to which farmers have adopted the technical package extended to them, and existence of various signs and conditions that signal the incorporation of fish culture into the cycle and mosaic of farm activity (Kent, 1987). Thus, the sustainability of aquaculture as a farm enterprise is an enduring issue, but one with immediate implications for farmers seeking alternative enterprises that improve nutrition, provide cash income, and reduce the risk of food shortage.

Extending Fish Culture to Farmers

Rwanda Fish Culture Project

The purpose of the USAID Rwanda Fish Culture Project (RFCP) is to assist the Ministry of Agriculture (MINAGRI) in the development of an Aquaculture Extension Service to provide technical assistance to Rwandan farm families. In its seven years of operation, the project has established four fish stations, trained over 58 extensionists, and helped establish over 1150 private ponds across its nationwide scope of responsibility.

A production system utilizing a tilapia species (*Orechromis niloticus*) has been widely implemented by farmers utilizing readily-available inputs to raise fingerlings to market-size (Moehl et al., 1988). Nearly 20 thousand farmers and family members are associated with the project (Hishamunda and Moehl, 1989).

Fish culture to date has been a largely male realm of endeavor, although approximately 550 women are on the project's extension rolls, primarily through their involvement in collective ponds. A large part of agricultural production in Rwanda is associated with the labor of farm women whose traditional responsibilities include hoeing, weeding, and

other care of crops, as well as tasks associated with children and the household. Women also participate in fish culture through family ponds and their spouses' membership in group efforts (Engle, 1987; Veverica, 1988).

Growing recognition of seemingly inexorable demographic trends and recent experience with short-term food shortages has focused attention on agriculture and the country's rural sector (DAI, 1986). Increasingly intensive use of highly vulnerable soil resources also has galvanized concern about the need for ecological balance in efforts to increase food production. The project has developed a prototype extension effort that trains extension representatives who assist farmers with pond construction, fish production, and related activities.

Fish culture extensionists make regular, predictable visits to farmers with systematic training and updating of information programmed into their activity cycle. Capable individuals have been recruited through the use of a pretest for basic literacy and language skills, as well as frequent examinations throughout the training period.

Aquacultural extension activities focus on fish production and pond management activities. Regular and predictable patterns of contact with farmers and in-service training assures that farmers have a reliable source of useful information to guide their production decisions (FAO, 1988). In some ways, the project has anticipated the national effort to incorporate some aspects of the training and visit extension system model to reorganize and focus extension assistance to farmers (Benor and Baxter, 1984).

Rwanda shares a context for extension work common to many African countries. Several different organizations offer irregular and uncoordinated services with inadequate resources supporting poorly trained and

underpaid technical assistants (FAO, 1988). Due to a shortage of foreign exchange, the Rwandan government has had difficulty sustaining newly created institutional structures after donor assistance terminates (Molnar and Jolly, 1988; FAO, 1987).

Access to Land for Aquaculture

A number of different units of social organization are associated with fish ponds in Rwanda. Each provides a somewhat different set of considerations for aquacultural development. These include: institutions, group ponds, and private ponds (operated by individuals).

Institutions such as schools, churches, prisons and other units operate fish ponds as a source of food, income, and training for participants. The institutions serve as important demonstration sites for their surrounding areas. They also provide fish culture experiences to large numbers of individuals. Representing a separate set of issues, they are not further considered in this report.

Pond groups are sets of individuals granted a shared plot of land for the purposes of fish culture. Pond groups often represent an extension clientele group with specialized needs. Members divide labor and other responsibilities, sharing in the resulting harvest. Although another ministry representative is responsible for organizing groups at the local level, leadership development and conflict resolution are additional issues that may confront the extension worker attempting to teach fish culture skills to groups (Molnar and Nerrie, 1987).

Private or individual ponds are operated by farmers and their families. These individuals have obtained the right to use communal land in the marias for the purpose of fish culture. The pond or ponds are usually situated in a complex of other plots in the marais. Marais plots, including fishponds, usually supplement privately-owned land

associated with a house and compound on the hill.

The distinction between group and individual ponds is an important one because local officials who make marais land allocation decisions often exhibit a clear preference for granting land to groups rather than individuals. Given large cohorts of young people seeking land, groups offer the opportunity to provide resources to a larger number of young farmers than if each plot were allocated to a single individual (West, 1983). Each plot then satisfies 8 to 12 land requests, alleviating some pressure on the official from the petitioning individuals and their family, friends, and neighbors (Molnar and Rubagumya, 1988).

Marais Lands and Aquaculture

Fishponds and aquaculture are one means for enhancing the productive use of resources in the flat, marshy areas between the hills called marais (Molnar and Rubagumya, 1988). These valley-bottom lands are the only source of additional agricultural land in Rwanda and fish ponds are an important use of this resource (Sikkens and Steenhuis, 1988). Other than the seasonal grazing of cattle, goats, and pigs, aquaculture is the major animal enterprise using these lands.

Marais lands have unique seasonal dynamics and cropping patterns that seem to be well understood by Rwandan farmers (Jones and Egli, 1984). Marais plots complement hill plots in sustaining food supplies and incomes. Yet the advance of technology is making fertilizer, new tools, and new plant varieties available. The introduction of these technologies requires far better management of the natural resource (i.e., the soils and hydrology of the marais).

Aquaculture monitors represent a trained cadre of personnel focusing their efforts on resource utilization in the marais. Due to population pressures and the necessity of making optimum use of marais lands,

there is a need for appropriate mechanisms for intensifying use while sustaining the productivity of these unique areas (Cambrezy, 1981; Sikkens and Steenhuis, 1988).

Ponds are the most enduring structure in the marais, although they too are occasionally destroyed by an extreme flood or purposely drained and leveled. Fish ponds have reciprocal relationships with other marais enterprises. Not only does aquaculture enhance other enterprises also enhance the productivity and economics of fish culture (Hishamunda et al., 1987). Ponds focus marais activity on the use and management of water resources. Gardens, animal pens, and irrigation may be integrated into the pond production system (Molnar et al., 1987). Thus, ponds are logical intervention points for coordinated and successive intensification of land use in the marais.

Sustainability as A Development Objective

Sustainability can be defined in different ways and sought through different means (Douglass, 1984). The concept encompasses more specific evaluative terms like effectiveness and efficiency, while implying a more holistic concern for the overall fit, congruity, and lasting incorporation of an intervention in an agricultural system (Bailey, 1990). The major issues in aquaculture relate to the institutional lodging of the intervention. Interventions that fail to sustain support and sponsorship within the national bureaucracy are destined to wither and dissipate. Production schemes that fail to win the confidence and enthusiasm of farmers will not generate food or revenue. As a consequence, a central aspect of sustainability is the extent to which the project concept is embraced by members of the target population (Molnar and Duncan, 1989).

When introduced in an environ where little or no fish culture had

been underway, success must be judged in terms of establishment of the support infrastructure, extension system, and marketing apparatus. The intensification or improvement of traditional agricultural enterprises can focus on farmer participation as well as the performance of the new breed or varieties, taking much of the rest of the system for granted (Cernea, 1985). Aquaculture projects often represent a much more complex array of interventions, bureaucratic transitions, and fundamental shifts in farm practice and decision-making (Molnar et al., 1987). Thus while farmer participation underlies the success of any aquaculture development effort, a variety of factors specific to fish culture contribute to its sustainability as a new farm enterprise (Ashby, 1982).

Sustainability includes various conditions and experiences that suggest continued development and integration of fish culture in the operator's farming system. Although broader perspectives emphasize on the long-term viability of whole agricultural systems (Senanayake, 1984:227), the focus here is on a specific activity in a complex cycle and array of enterprises.

A significant aspect of sustainability is the elimination of dependence on government services for continuing the farm enterprise. In some locales, seedstock is produced by the public sector that oversees its distribution and utilization by fish producers. In such situations, the overall success of the national program in aquaculture turns on the efficacy of the hatchery system to generate seedstock. At later stages of development differentiation may occur among producers and better farmers may become seedstock suppliers in their local areas.

Some of the critical benefits of fish culture lie not in marketplace returns but in food security during the beginning of the rainy season when food is often scarce (Molnar and Rubagumya, 1988). Similar-

ly, fishponds generate significant secondary benefits when they precipitate irrigated gardening and other types of animal husbandry that have complementary relationships to fish production. These related benefits need to be taken into consideration when the sustainability of aquaculture in a locale is assessed.

Donor agencies have fairly well-established guidelines for evaluating projects and these are readily generalizable to aquaculture (USAID, 1980; Casley and Kumar, 1987a; 1987b). There are, however, some ways that the implementation of fish culture may not be adequately portrayed by these frameworks or evaluation criteria. Some types of aquaculture may involve rather dramatic transformation of resources. Shifting swamps to shrimp production may displace previous users and alter the tenure standing of fishermen and others residing or working in the affected areas (Bailey, 1988). Such projects also have the potential to create a new class of wealthy people exacerbating inequality while increasing the overall level of wealth and income in an area.

Figure 1 diagrams factors influencing the sustainability of fish culture in Rwanda. **Organizational context** refers to features of the setting under which fish culture is conducted. One organizational dimension salient in Rwandan aquaculture is whether the activity is undertaken as a group or cooperative enterprise (Schwartz et al., 1988; Molnar et al., 1985). When access to land or project services is premised on participation in a pond group or cooperative, an additional array of organizational and management issues is introduced. The internal dynamics of a group has a great deal to do with the quality of management and subsequent success of the farm enterprise.

Groups are characterized by certain costs and delays in decision-making that undermine their efficiency relative to the individual

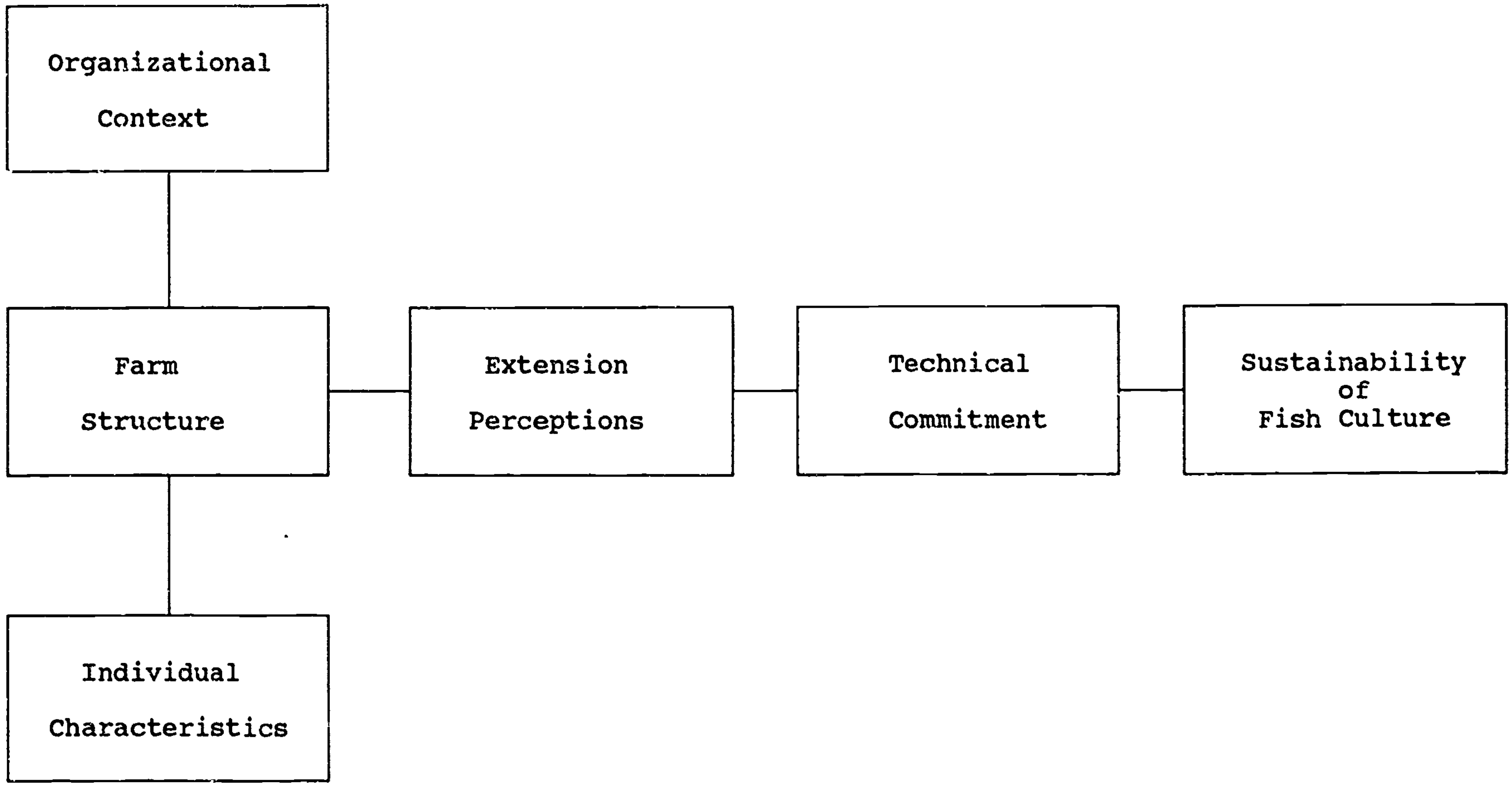

Figure 1. Factors influencing sustainability of fish culture as a farm enterprise.

owner-operator form of organization. Panamanian experiences suggest that local leadership and community social inequality affect pond group proficiency (Schwartz et al., 1988). The literature on group farming suggests that family-based groups are reinforced by the natural hierarchy within the family that facilitates decision-making and the distribution of rewards (Molnar et al., 1985).

In Rwanda, preliminary studies suggest that group-based aquaculture may be centra perceived as a means of access to land and income in that land-short, densely-populated nation. Group farming also may facilitate resource allocation decisions by local authorities who find that farm plots allocated to groups satisfy 8 or 12 individuals and their families, while use-right grants of communal land to a single individual can be a source of controversy and criticism (Molnar and Rubagumya, 1987; Robins, 1985).

Extension perceptions reflect assessments of technical assistance and the nature of services received. The predictability of extension visits has been identified as a key aspect underlying the quality of extension programs (Benor and Baxter, 1985; Murphy and Marchant, 1988). Similarly, farmers should express some satisfaction with the lessons that monitors are conveying as well as some sense that the extensionist is able to solve routinely encountered production problems.

Technical commitment reflects the degree to which the operator has embraced the technical package extended by the project. Compliance with project recommendations can be observed through checklists assessing weed control, evidence of pond fertilization, and maintenance of water quality (Beebe, 1984; Chambers, 1987). Production and yield data require sustained efforts to monitor reproduction and growth in an often widely-dispersed network of ponds. Therefore it may be appropriate to

use simple indicators that can readily be elicited in a survey interview.

Farm structure refers to the size and activities of the operation and its holdings. The relative wealth and complexity of an individual farmstead may influence the relative fit of a new farm enterprise. Farmers with few resources may give greater attention to a new enterprise because it represents a larger share of their productive activity.

Individual characteristics include the personal and social attributes of the operator. Attention to needs for socioeconomic compatibility does pay off in economic terms -- among others -- in economic rates of return twice as high as those in socially insensitive and inappropriate projects (Kottak, 1985: 326). But such indicators may not show the actual social worth or benefit (Glaser et al., 1983).

Rates of return to tilapia production in Rwanda are difficult to interpret due to the many shadow prices which must be estimated and assumptions have to be made about labor, inputs, and other factors that are not readily assessable or comparable to Weste . economic frameworks (Moehl and Hishamunda, 1988). For these reason it is important to consider the relative perceptions of various socioeconomic categories of project participants to understand the long-term fit and impact of fish culture.

DATA AND METHOD

Sample

Data were obtained from a sample of 186 Rwandan farmers taken from project rolls in 10 selected communes (local districts). Figure 2 shows the location of the sample communes. Interviews were conducted in May-July 1989.

Respondents were sampled in a two-stage probability-in proportion

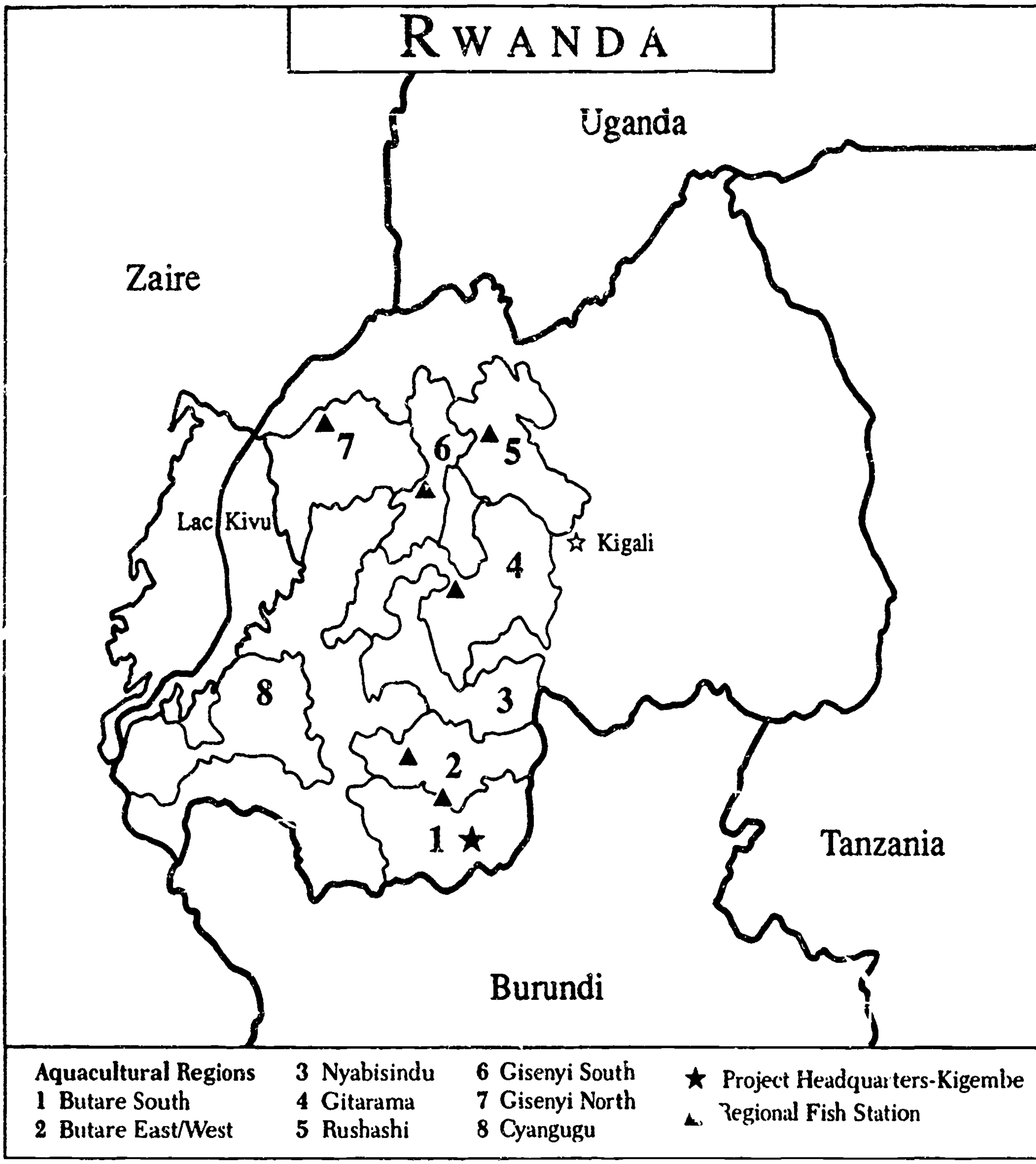

Figure 2. Map of Rwanda

to size procedure. All project communes served by extension monitors were listed and the number of active fish ponds recorded. In the first stage of sampling, eight communes were selected according to probabilities corresponding to the number of ponds in the commune. Two additional communes were purposively selected to represent certain altitude and climatic conditions.

In the second stage, approximately 20 farmers were selected from project rolls in each of the ten sample communes using systematic random procedures. Some sample communes had less than 20 active fish farmers. In these situations, all available individuals were interviewed. The 186 respondents in the sample represent an 88 percent completion rate (Casley and Lurey, 1981). The data are representative of project participants who had active ponds in the previous two years and who received extension services during that period.

Project staff, Rwandan officials, and a number of expatriate development professionals aided in developing a survey instrument and identifying a sampling strategy. After initial pretesting and revision of the instrument, a Rwandan national contacted sample respondents and conducted interviews in the native Kinyarwandan language. The instrument was precoded to facilitate data entry and analysis of fixed response items; other qualitative information was transcribed and translated.

Data Collection

To contact the sample farmers, extension monitors were asked to make arrangements with the sample respondents to meet the interviewer at arranged locations and times. At short notice, a call for a meeting of extension monitors was broadcast over the Kigali radio. Seven of the eight monitors assembled at the Kigembe research facility to discuss the study and procedures for mobilizing respondents. The eighth monitor was

contacted directly.

After explaining the objectives of the study, each monitor was asked to provide specific location data for each farmer and other information about the timing of umuganda(community work period) and periods of high likelihood of encountering farmers in the marais.

The monitors were individually consulted as to a convenient time and place for mobilizing respondents from their commune. A day, time, and assembly point was established for each monitor.

On the appointed days, the interviewer met the farmers and conducted individual private interviews. After a short preamble explaining the study, the questionnaire was administered and responses recorded. The interview concluded with a general discussion of the farmer's situation, the circumstances of the marais, and matters related to fish production, marketing, and consumption.

Interviews were conducted in a variety of settings including school rooms, commune offices, alleyways, and the marais. Approximately 50 minutes was spent with each farmer. Data were available for 186 farmers from 45 different marais in 10 different communes throughout the nation.

Measurement

Data were obtained to profile six different aspects of fish culture in Rwanda. Sustainability is reflected in four different indicators of the relative ability of fish to remain a stand-alone enterprise with extensive government interventions. Fingerling sales reflect whether farmers were marketing seedstock to their neighbors. Planning new ponds is indicative of intentions to continue and to expand fish culture. Self-sufficiency is a self-rated assessment of the ability to do without extension assistance. Complementarity of fish culture with other activities is measured by counting two questions determining whether fish

culture interfered with other activities and whether fish fit into the farmer's overall pattern of work.

Technical commitment measures various aspects of adherence to the technical package extended by the project. Pond visit frequency is how often the farmer attended to the pond. Time spent per visit was a self-reported estimate. Fish feeding frequency was how often farms put manure or other nutrients in the ponds. Number of feeds used counts how many different kinds of substances farmers fed their fish.

Extension perceptions assess various aspects of the quality and quantity of technical assistance. Helpfulness index counts the number of different aspects of extension assistance farmers mentioned as having been helpful to them. Satisfaction index counts the number of affirmative responses to a series of direct questions about monitor assistance. Monitor visit frequency is the reported number of times the extensionist consulted with farmers per month. An important aspect of extension assistance is whether the monitor comes when expected.

The organizational context of aquaculture includes various aspect of ownership and operation of the pond. Fish culture is conducted by individuals or as a group enterprise by a number of individuals working together. Women's group is contrasted with individual operators and groups that were exclusively male. Number of food enterprises reflects the complexity of the individual's farming system. Number of cash enterprises reflects the diversity of income-producing activities.

Farm structure refers to various aspects of the size and complexity of the operator's landholdings and activities. Number of marais plots counts the number of holdings in the marshy valley areas. Number of hill plots counts the number of privately owned pieces of hill land. Number of private ponds counts the number of fishponds operated by the

individual outside of a group. Number of different marais counts the number of different valley areas where the individual held fishponds.

Individual characteristics indicate whether the respondent was female, age in years, married or not, as well as the number of years in fish culture.

FINDINGS

Sustainability

Table 1 shows the distribution of responses to four survey items reflecting the sustainability of fish culture. More than half the farmers had engaged in fingerling sales. Although small fish can also be purchased for consumption, such transactions reflect the availability of seedstock from nongovernmental sources and consequently, reduced dependence on state-run hatcheries.

About 91 percent of the respondents planned new ponds, suggesting a positive outlook or trajectory for fish culture. Nearly as many respondents thought they could do without extension assistance.

Respondents were asked two questions about possible conflicts fish culture with their other activities. The combined index shows little felt incongruity with other enterprises.

Table 2 shows correlations between sustainability indicators and other variables used in the study. Technical commitment variables did not correlate with sustainability measures. The four measures of adherence to the technical package were not associated with the durability or integration of aquaculture.

With regard to extension perceptions, the helpfulness index was correlated with fingerling sales. The frequency to which extension monitors visited the farmer was associated with plans for new ponds. No other extension indicators were related to sustainability. None of the

other variables were related to the sustainability indicators used in this study.

Technical Commitment

Table 3 shows the frequency distribution of various measures of technical commitment to fish culture. Most operators visited their ponds every day. Most spent about an hour on each visit. Similarly, 58 percent reported daily feeding. Finally, while about a fourth of the farmers mainly used one or two substances as pond inputs, 24 percent mentioned five or more items as fish feeds.

Table 4 regresses technical commitment indicators on four other variable sets in the conceptual model. When monitors visited more frequently, farmers attended to their ponds more frequently. In aggregate, however, these variables explained only a minor proportion of the variation in pond visit frequency.

The variables explain about a third of the variance in the time the operator spent per pond visit. When monitors visited more often, farmers spent more time with their ponds.

Women and operators with more cash enterprises reported shorter visits, but operators with more food enterprises tended to report staying longer on each visit.

The variables did not explain a significant proportion of variance in the fish feeding indicator. More frequent monitor visits led to more frequent feeding, but those who gave lower helpfulness ratings also fed their fish more frequently.

Number of feeds used was negatively associated with the frequency of extension visits. The number of cash enterprises was positively associated with this indicator, suggesting that wealthier farmers had more byproducts to put in their ponds. Similarly, farmers with a great-

er number of marais plots also reported a greater variety of pond inputs. These variables explained about 18 percent of the variance in number of feeds used.

Extension Perceptions

Table 5 profiles farmer ratings of various aspects of the technical assistance they received. Some farmers mentioned five or more aspects of fish culture for which the extensionist was helpful. Most respondents gave affirmative responses on all five of the specific subjects where monitors were expected to be informed and useful.

There was a great deal of variability in the monthly frequency of monitor visits. Most saw their extensionist at least twice a month. About 24 percent felt that the monitor never came when expected. The predictability of visits is a significant aspect of the quality of extension services.

Table 6 regresses extension perception indicators on the three remaining variable sets in the model. The number of hill plots and the number of cash enterprises was negatively related to the helpfulness index. Farmers with more landholdings gave lower ratings of extension services. Wealthier farmers were less happy with the utility of the technical assistance they received. Women gave the male extensionists lower helpfulness ratings.

The three variable sets did not explain a statistically significant proportion of variation in the satisfaction index. Women were less satisfied with the services they received from the fish culture monitors.

Monitors made less frequent visits to group enterprises. Similarly, they made less frequent contacts with farmers with many cash enterprises and many private ponds. Farmers with ponds in more than one

marais had more frequent extension visits, however. Farmers with more years of experience had more visits from the monitor. These variables explained about 27 percent of the variation in the monitor visit frequency variable.

The predictability of extension visits was negatively associated with the number of cash enterprises. The more market-oriented farmers with many cash enterprises were more likely to feel that extensionists did not always come when they were expected. Similarly, wealthier farmers with more hill plots felt that the monitor's visits were less predictable. These variables explained about 14 percent of the variance in the predictability item.

CONCLUSION

Sustainability is a central long-term objective of development interventions and is an important question for aquaculture (Ben-Yami, 1986). The incorporation of fish culture as a new or modified farm enterprise into a farming system was examined in terms of farmer outlooks and practices. Figure 3 summarizes the observed empirical correlations in the Rwandan farm data. It shows shows few connections between sustainability and the degree to which farmers have grasped the technical aspects of fish culture or their perceptions of the extension assistance provided to them. The reasons for this independence are both substantive and methodological.

The several aspects of sustainability beg the ultimate question of the state of the project five years after the long-term staff has left the country. The commitment of the Rwandan government may waver or firm. It may or may not continue to pay monitor salaries, to provide sufficient resources for recruiting and training replacements, and to allocate sufficient travel funds for the extension monitors. Farmers

have little way of knowing or understanding the larger national questions about the direction of agricultural policy or the status of foreign exchange accounts and the need to redirect spending to export crops. Thus, the survey responses suggest a relatively uniform expectation for continuing fish culture, even though many of the factors affecting the sustainability of aquaculture as a farm enterprise relate to the provision of infrastructure that is beyond farmer control.

The methodological aspects of the observed lack of association relate to the same uniformity of response. Most respondents planned new ponds, most felt capable of doing without extension assistance, and very few reported conflicts with other enterprises. Thus there was little variability in these indicators to be explained.

The respondents in this study are a selected set of farmers who had fish ponds, had at least one harvest in the past year, and had regular contact with extension. Disaffected individuals who had given up fish farming, those who had ponds and were not receiving extension help, and other potential beneficiaries of fish culture were not included in the study. Thus some of the variability in some indicators is censored due to the nature of the sample.

A great deal of spontaneous emulation is occurring outside the project. Neighbors and relatives of project farmers are constructing fish ponds, often without proper technical guidance. One threat to the evolution of fish culture is that improperly constructed ponds that are too small, leaky, or have continuous water flows (keeping water temperatures low) will undermine the success achieved by project participants.

An important next step in the evolution of the project is to identify spontaneous emulators and provide the necessary corrective or augmenting technical assistance to assure the proper realization of fish

culture. The early unsuccessful Belgian experience with fish culture used an improper species and poor technology. The resulting failures and frustrations discouraged expansion and many ponds reverted to land crops. Avoiding unnecessary failures and retarding the use of poor technology and inappropriate species will be a significant phase in the next rhase of fish culture extension programming.

The individuals experiencing the most conflict with fish culture were women. As is largely the case throughout Africa, Rwandan women have responsibility for water, firewood, and food crops. Thus they are the individuals most heavily burdened by other activities and most likely to experience a role conflict while incorporating a new enterprise into their array of responsibilities.

Women respondents were more likely to report that fish farming interfered with other farm activities. Women also were less satisfied with the extension services they were receiving and rated their monitor as helpful on fewer dimensions than men. Traditional gender relationships appear to color the treatment some women recieve from monitors.

Aggressive, innovator farmers with more ponds, more land holdings, and more cash enterprises were them most dissatisfied with extension assistance. These entrepreneurial individuals may be more adept at "pulling down" extension assistance (Roling, 1989). Innovators are important as examples and as often influential members of their social system. Nevertheless, they also may represent a group that is less in need of assistance. They may present a distributional or equity question about the allocation of extension resources.

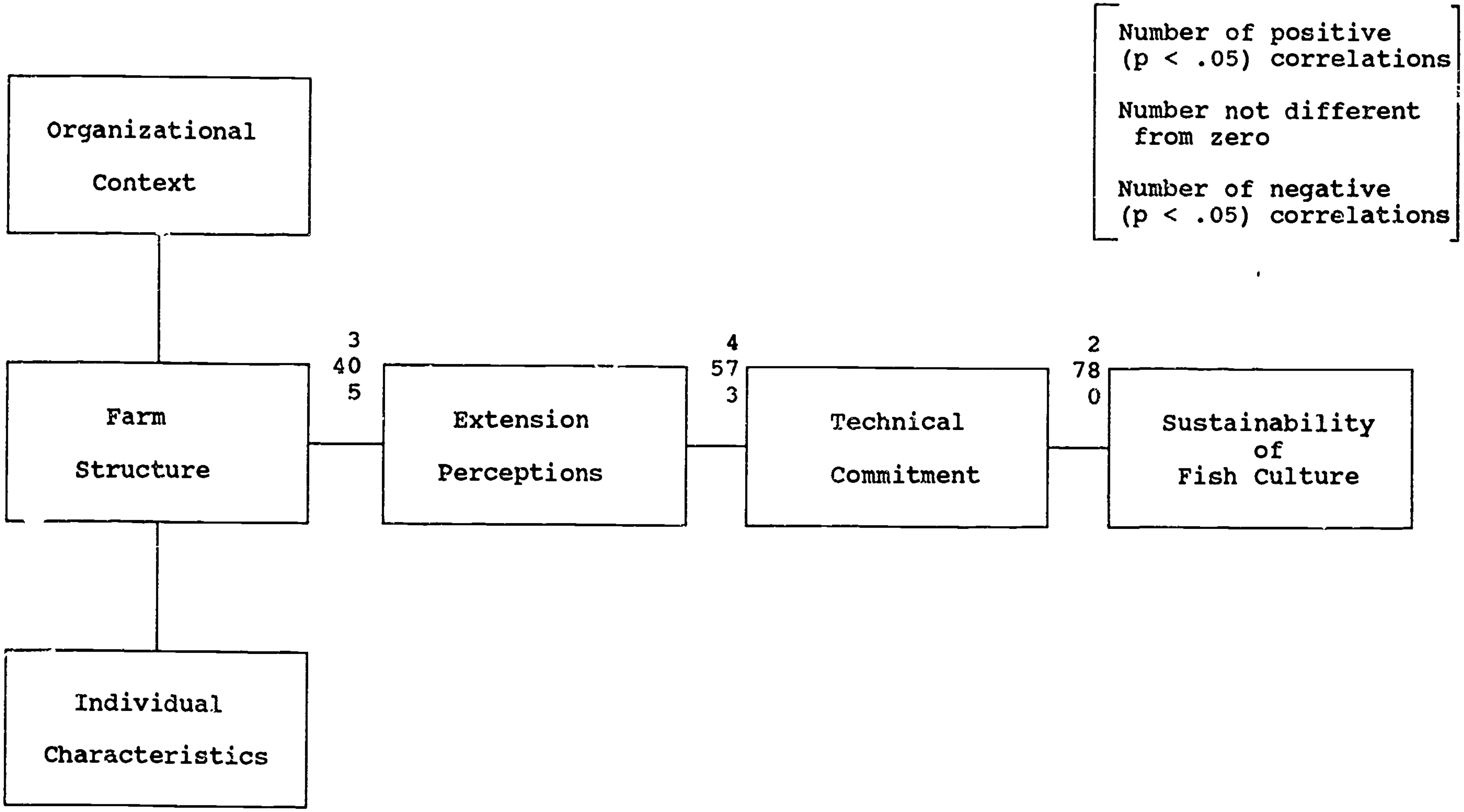

Figure 3. Summary of empirical correlations

Table 1. Indicators of sustainability for fish culture as a farm enterprise, Rwanda, 1989

Indicator - definition	Number	Percent
Fingerling sales - cash marketing of seedstock		
No	76	41
Yes	10[illegible]	59
	(1)	
Plan new ponds - anticipate expansion of fish culture		
No	17	9
Yes	169	91
Self-sufficiency - know enough to do without extension assistance		
No	26	14
Yes	160	86
Complementarity index - fit of fish culture with other farm activities		
Low	2	1
Medium	3	3
High	111	96
	(70)	

Table 2. Correlations between sustainability indicators and selected situational and individual characteristics, Rwanda, 1987

Variable	Fingerling sales	Plan new ponds	Self-sufficiency	Complementarity index
<u>Technical commitment</u>				
Pond visit frequency	-.12	.00	-.08	.07
Time spent per visit	-.04	.13	.00	.12
Fish feeding frequency	-.13	.02	-.12	.13
Number of feeds used	-.00	-.17	.13	-.02
<u>Extension perceptions</u>				
Helpfulness index	.18*	.07	.02	-.09
Satisfaction index	.13	.08	.05	-.04
Monitor visit frequency	-.09	.19*	-.04	.15
Comes when expected	-.01	.13	-.02	-.10
<u>Organizational context</u>				
Group enterprise	.12	-.06	.01	-.14
Women's group	-.05	-.02	.04	-.09
Number food enterprises	-.05	.01	.04	-.03
Number cash enterprises	-.11	-.11	-.02	-.11
<u>Farm structure</u>				
Number of marais plots	-.06	-.13	.02	-.06
Number of hill plots	.07	-.09	.07	-.09
Number of private ponds	.01	.07	.04	-.08
Number of different marais	.01	-.03	.04	.04
<u>Individual characteristics</u>				
Female	-.04	-.02	-.14	-.03
Age	.09	-.09	-.16	-.04
Married	.10	.00	-.06	-.05
Years in fish culture	.00	.12	.04	.15

N=186 * $p < .05$
** $p < .001$

Table 3. Indicators of technical commitment to fish culture, Rwanda, 1989

Indicator - definition	Number	Percent
Pond visit frequency		
Every day	94	50
Almost every day	1	1
Several times a week	73	39
Once a week	16	9
Less often	1	1
(missing)	(1)	
Time spent per pond visit		
Less than an hour	26	15
About an hour	96	53
Two or three hours	29	16
More than three hours	29	16
	(7)	
Frequency of feeding		
Every day	107	58
Almost every day	--	--
Several times a week	71	38
Once a week	7	4
	(6)	
Feed diversity-number of different fish feeds used		
One	12	7
Two	36	19
Three	47	25
Four	44	24
Five	29	16
Six or more	14	8
	(3)	

Table 4. Regression of technical commitment indicators on selected personal and contextual variables, Rwanda fish farmers, 1989

Variable[a]	Pond visit frequency	Time spent per visit	Fish feeding frequency	Number of feeds used
Extension perceptions				
Helpfulness index	-.13	--	-.14*	--
Satisfaction index	--	--	.12	--
Monitor visit frequency	.23	.43**	.26*	-.24**
Comes when expected	--	.09	--	--
Organizational context				
Group enterprise	.26*	.11	--	--
Women's group	--	-.11	--	.10
Number food enterprises	--	.12*	--	.11
Number cash enterprises	--	-.21**	--	.25**
Farm structure				
Number of marais plots	--	--	--	.15*
Number of hill plots	--	-.10	.10	.11
Number of private ponds	--	.10	--	--
Number of different marais	-.09	.11	--	--
Individual characteristics				
Female	--	--	--	-.09
Age	.12	--	--	--
Married	--	--	-.14	--
Years in fish culture	-.11	.09	--	--
R^2	.14	.40	.12	.25
Adjusted^2	.04	.34	.03	.18
F-value	1.5*	6.8**	1.4	3.6**

[a] Coefficients greater than or equal to their standard errors are shown, although all variables were included in each equation.
* Coefficient twice standard error.
** Coefficient three times standard error.

Table 5. Indicators of fish culture extension perceptions, Rwanda, 1989

Indicator - definition	Number	Percent
Monitor helpfulness index - count of helpful aspects of monitor assistance		
One	9	5
Two	39	21
Three	94	51
Four	28	15
Five or more	14	8
	(2)	
Monitor satisfaction - rating of five aspects of monitor assistance		
One	2	1
Two	1	1
Three	1	1
Four	6	4
Five	144	93
	(32)	
Monitor visit frequency - times per month		
Never	1	1
Once	20	12
Twice	48	28
Three times	20	11
Four times	51	30
Five or more	32	18
	(14)	
Monitor comes when expected		
No	42	24
Sometimes	87	49
Always	50	28
	(7)	

Table 6. Regression of extension perception indicators on selected personal and contextual variables, Rwanda fish farmers, 1989

Variable[a]	Helpfulness index	Satisfaction index	Visit frequency	Comes when expected
Organizational context				
Group enterprise	--	.09	-.31**	-.13
Women's group	.12	--	--	--
Number food enterprises	--	--	.10	--
Number cash enterprises	-.19*	--	-.33**	-.25**
Farm structure				
Number of marais plots	--	--	--	--
Number of hill plots	-.16*	--	.07	-.18*
Number of private ponds	--	--	-.12*	--
Number of different marais	--	--	.17*	-.15*
Individual characteristics				
Female	-.12*	-.14*	--	.09
Age	--	--	--	.11
Married	-.14	--	--	.13
Years in fish culture	--	--	.24**	-.09
R^2	.13	.04	.32	.19
Adjusted R^2	.07	.03	.27	.14
F-value	2.2*	.6	6.6**	3.4**

[a] Coefficients greater than or equal to their standard errors are shown, although all variables were included in each equation.
* Coefficient twice standard error.
** Coefficient three times standard error.

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